

# U.S. Patent Application for

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## AUTOSCALING/AUTOSIZING USER INTERFACE WINDOW

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### BACKGROUND OF THE INVENTION

The present invention relates generally to the field of physical systems and networks, and to displays for representing such systems. More particularly, the invention relates to a technique for scaling and viewing reconstructed representations of a system or physical implementation of a set of objects.

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Various physical systems are configured and built in accordance with reconstructed representations viewable on computer monitors and the like. Displays of systems, diagrams, physical views, and so forth are typically provided on computer monitors in windows or viewing areas which may be resized by setting scaling factors or by dragging sizing tools, such as with a mouse or similar input device. Where proportionate sizing is desired, certain applications allow for resizing of vertical and horizontal dimensions uniformly to maintain proportions in those directions. Such resizing does, however, alter the level of detail visible in the display, making relatively small features difficult to view.

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In applications where less than a complete view of a system or image can be had in a window, it is common to provide a scroll bar or similar virtual tool to permit a user to displace the virtual image within the viewing window. A user may thus survey portions of a representation viewable in the display window, so as to select features of interest, which may be seen in greater detail by zooming in or out on such features as desired. Certain applications incorporate both this selectable viewing and scrolling feature with scaling of horizontal and vertical dimensions.

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Certain types of representation are difficult to view in conventional windowing and scaling programs. For example, where the subject matter of depiction has discrete

units or sections which are logically displayed in groups, scaling alone does not maintain a desired level of detail visible when the window size is reduced on a monitor. Where the detail is desired, zooming may be available, but conventional zooming algorithms increase an entire area of a representation, without distinction between logical boundaries between items in the depiction or their grouping.

By way of example, in an industrial automation context, systems of components may be associated with one another in a physical layout. The system view may be reconstructed to approximately represent the layout of the components. Where the components are situated in enclosures, then, the approximate positions of components in the enclosures may be depicted in the representation viewable by the user on a monitor. The user may then desire to maintain a view of suitable size to read indicia or text labeling on the components, but may not want the entire monitor screen to be occupied by the system view, making scaling of the entire image alone unsuitable. However, where zooming functions are utilized, specific component sections may no longer be viewable in the reconstructed representation, making partial sections alone viewable which are not useful to the user.

Similar issues arise in representations of other types of systems. For example, architectural representations may include distinct subunits, such as sections or floors of a building which are most usefully viewed as subunits. Where scaling alone is used, detail of the specific features may be lost, while zooming alone does not take into account the discrete groups of components which may comprise a building sections or floor. Diagrammatical representations, including charts, system diagrams, and the like may also include logical groupings which would be best viewed together, despite a level of scaling or zooming which is selected by a user.

There is, at present, a need for an improved windowing and scaling technique which can permit such viewing of logical groupings, while allowing for scaling of an overall system or representation.

### SUMMARY OF THE INVENTION

5 The present invention provides a novel technique for sizing and scaling a  
representation on a computer monitor designed to respond to these needs and drawbacks of  
existing approaches. The technique is particularly well suited to use in software which  
allows for viewing of physical system layouts, diagrams, and the like, wherein components  
or features are associated into groups. A user may desire viewing of one or more of the  
groups as discrete units to maintain visibility of specific details. The groups are then  
10 defined for presentation in the representations, and the group associations are maintained in  
the depiction displayed within a viewing window.

15 The technique conveniently allows for scaling in one direction and snap-type feature  
selection in a second orthogonal direction. For example, in a physical depiction of a  
system, a vertical direction may be autoscaled by dragging a virtual tool on the display,  
such as via a mouse. The scaling in the vertical direction then proportionately changes the  
size of the elements depicted in the representation. Resizing in the horizontal direction then  
allows for selection of discrete subsections or units of the physical system depicted in the  
image. The sections may include machine elements, system components, or any other  
20 logical association of the elements of the representation. Thus, when the representation is  
resized in the horizontal direction, no loss of feature detail is experienced by the user,  
although the number of logical groups displayed or expanded is reduced. Additional  
windowing may be offered, such as through scroll bars, allowing the user to view other  
logical groupings eliminated from view by the resizing selection.

25 The technique may, of course, be adapted for various types of systems, and for  
scaling or sizing in vertical, horizontal, or other directions. In an exemplary  
implementation, horizontal and vertical directions are utilized, with an exemplary depiction  
being of a motor control center in an industrial automation setting. However, the inventive  
30 technique is applicable in a range of fields, where user viewable depictions or

representations include logical groupings of features that for which details could be lost or less useful or viewable by the user if scaling and zooming alone are employed.

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### **BRIEF DESCRIPTION OF THE DRAWINGS**

The foregoing and other advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

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Figure 1 is a diagrammatical representation of an exemplary physical system and of a viewing station for producing a user viewable representation of the system in accordance with aspects of the present technique;

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Figure 2 is a more detailed representation of the exemplary physical system of Figure 1, illustrating logical groupings and dimensions of the physical system which are manipulated in your user representation;

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Figure 3 is a representation of the physical system of Figure 2 on a monitor, illustrating a full vertical scaling of the representation to provide a maximum degree of detail for system components;

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Figure 4 is a representation that like of Figure 3, but wherein the depiction of the system has been rescaled in a vertical direction;

Figure 5 is a representation such as that shown in Figure 4, wherein the viewing window in which the system depiction is provided has been resized by selection of portions of the system in accordance with logical associations or groups of components, with no loss of detail; and

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Figure 6 is a flow chart illustrating exemplary steps in control logic for producing and manipulating the representations shown in the foregoing figures.

**DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS**

5           Turning now to the drawings, and referring first to Figure 1, a system 10 is  
illustrated for viewing representations of systems having components or elements which are  
logically grouped. In the illustrated embodiment, system 10 is designed to be connected to  
a system, such as in an industrial automation context, and produce dimensionally  
approximate physical layout views of equipment. The representation 12 is displayed for  
10       manipulation and observation by a user as described more fully below. System 10 includes,  
in the illustrated embodiment, the actual physical system 14 of which the representation is  
made. The physical system 14, in turn, includes sections or groups 16 comprising  
associated components which are represented as such in the representation. The system  
further includes a viewing station 18 comprising a computer 20, a monitor 22 on which the  
15       representation 12 is displayed, and input devices such as a keyboard 24 and a mouse 26.  
Other peripheral devices may include output devices such as a printer 28.

20           The viewing station includes hardware and software for storing the representation,  
or for building the representation in real time in accordance with aspects of the present  
technique. Any suitable computer workstation may be employed for viewing station 18.  
The viewing station also includes memory devices such as a disk drive 30 designed to  
receive optical, magnetic, or any suitable memory support medium 32. In the illustrated  
embodiment, the viewing station 18 is designed to be connected directly to a data network  
34 linked to the physical system 14. In an industrial automation context, data network 34  
25       may include cabling, connectors, transceivers, and any other interface circuitry for  
exchanging device data via a predefined protocol. In a present embodiment, the data  
network 34 enables data to be collected from the components of physical system 14 for  
building the representation 12 in the viewing station. Other data useful in the functions of  
the viewing station, including the building of the views described herein, are stored on data  
30       files 36 either within the viewing station or external to the viewing station. Moreover, the

viewing station may draw data from remote resources 38, such as via a wide area network 40, including the Internet.

5 The illustrated embodiment enables representation to be generated for physical systems in real time based upon data extracted from the physical system itself. By way of example, data may be stored in the physical system, such as in system components, which is indicative of the identity of the components, their physical position within the system, their dimensions, and so forth. Based upon such data, the viewing station can reconstruct, in real time, a representation providing an approximate dimensionally accurate view of the components and the various groups in which they are disposed. It should be noted, however, that the present technique may find application in other settings, in which representations are made based upon data files alone. Similarly, the scaling and sizing techniques described herein may find application in software which does not represent a physical view of a component or a system, but represents diagrammatical views, such as charts, diagrams or the like.

10 Figure 2 illustrates in greater detail the exemplary physical system 14 which is reproduced in the representation. The physical system illustrated includes a series of eight sections or logical groupings 16. The overall width of the physical system is indicated by reference numeral 42, while its height is represented by reference numeral 44. In the case of physical system 14, the group 16 comprise vertical sections placed side-by-side. The section widths 46, 48, 50, 52, 54, 56, 58, and 60 are in the illustrated embodiment equal in dimension, although this need not be the case. Within each logical group 16, a series of components 62 are positioned. In an industrial automation context, for example, the components may include electrical devices for controlling delivery of power to loads such as electric motors, actuators, and so forth. The components themselves may include such devices as relays, circuit breakers, contactors, motor controllers, motor starters, and so forth.

25 The groups 16 of components are predefined by a logical association. In the exemplary embodiment illustrated, this logical association is simply the disposition of the

components in vertical sections. Because the representation desired in this example is a physical layout view of the components, the logical association of the components in vertical groups permits the user to locate individual components in the groups, such as for servicing, maintenance, or ongoing monitoring. In other contexts, however, the logical groupings may include horizontal sections, horizontal and vertically limited areas or regions, or any other logical sub-grouping of the elements depicted in the representation.

The representation 12 of the exemplary system illustrated in Figure is shown in somewhat greater detail in Figure 3. As illustrated in Figure 3, the representation is reproduced in a conventional monitor screen 64 viewable by the user. The screen includes one or more tool bars 66 which comprise a series of textual labels, icons, actuatable virtual devices, and so forth. A display area 68 is available for the representation, and a window including the component depiction 70 may be expanded to the extent of the display area 68.

In the view illustrated in Figure 3, the physical system 14 shown in the previous figures is depicted including labels 72 for each component, along with a status icon 74. The labels 72 and status icons 74 are illustrated by way of example. In practice, any features or details in the representation may be displayed, and are treated in the scaling and sizing of the representation as described below. In the illustrated embodiment, a legend 76 accompanies the component depiction 70.

The component depiction has a height 78 as shown in Figure 3, and a width 80. The height and width of the depiction determine the number of logical groupings shown, as described more fully below. In general, however, the height 78 is used in the present embodiment to define scale of the component depiction 70, while the width 80 defines the number of groupings illustrated. The aspect ratio of the groupings, however, is maintained in the sizing and scaling operations. Where the scaling performed by selection of the appropriate desired height 78 does not permit all of the groups to be illustrated in the component depiction 70, a scroll bar 82 is provided adjacent to a depiction, allowing the user to scroll to a different portion of the system by integer snapping to the logical groups.



In the example of Figure 3, six of the eight sections of the physical system fit within the component depiction 70.

As noted above, the representation may be scaled, in a vertical direction in the present embodiment. Figure 4 illustrates the representation of Figure 3 rescaled in a vertical direction by use of a virtual drag tool 84. The drag tool 84 may select any suitable location, or specific locations on the depiction such as a corner 86 in the illustrated embodiment. As the corner is dragged inwardly, to a desired new height 88, the entire system depicted in the representation is rescaled accordingly. While the height is rescaled in the illustrated view of Figure 4, the width 90 is maintained equal to the width 80 of Figure 3. Because the width to height ration permits more discrete groups to fit within the view, while maintaining the same aspect ratio of the individual components and groups, all eight sections of the physical system are now viewable. It should also be noted that, while the components are rescaled, labels, status icons, and the like may be similarly rescaled or may maintain an original size. Details of the groups and sections, however, are maintained for viewing by the user.

The user, in addition to rescaling in the vertical direction, may resize the representation in a horizontal direction as indicated in Figure 5. As shown in Figure 5, a drag tool 84 may be used to maintain height 92 equal to height 88 of Figure 4, while altering the desired width 94 of the depiction. The height of the depiction could, of course, be altered as well, but is maintained constant between Figures 4 and 5 for explanatory purposes. Because the new width 94 of the depiction does not permit the entire system to be viewed without rescaling the aspect ratio of the components or groups, the number of groups illustrated in the depiction is reduced, to four sections in the example shown. Again, because the number of groups illustrated is reduced, a scroll bar 82 is inserted below the depiction, thus, although the user has made available a greater portion of the display area 68 for other documents, views, applications, windows and the like, no loss of feature detail is experienced between the manipulations made from Figure 4 to Figure 5.

Figure 6 illustrates the scaling and sizing operations which are performed in the foregoing technique. As shown in Figure 6, a representation 12 is made of a physical system, in this case having a width  $W$  and a height  $H$ . The aspect ratio of the individual groups of the representation is defined, however, by the ratio of the image width to height, or  $w/h$  as shown in Figure 6A. When the height is adjusted as shown in Figure 6B, the new height  $H'$  causes the vertical and horizontal rescaling of the represented image, thereby maintaining the same original aspect ratio of the groups and component representations, producing a new aspect ratio  $w'/h'$  which is equal to the ratio  $w/h$ . As a new width  $W'$  is then selected, a number of groups in the view is reselected to maintain the aspect ratio defined by  $w'/h'$ , as shown in Figure 6C. Thus, the technique permits rescaling in a first direction as between the views of Figures 6A and 6B, with resizing as between Figures 6B and 6C, without reduction in the aspect ratio of the groups or loss of detail.

While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown in the drawings and have been described in detail herein by way of example only. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.